

Conversational profiles of children with ADHD, SLI and typical development

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Abstract

Conversational indices of language impairment were used to investigate similarities and differences among children with Attention-Deficit/Hyperactivity Disorder (ADHD), children with Specific Language Impairment (SLI) and children with typical development (TD). Utterance formulation measures (per cent words mazed and average number of words per maze) differentiated the ADHD group from the SLI and TD groups (ADHD > TD = SLI). In contrast, measures of lexical diversity, average sentence length and morphosyntactic development (number of different words, MLU, and composite tense) differentiated the SLI group from the ADHD and TD groups (SLI < ADHD = TD). High levels of within group variation were observed in children's speaking rate (words per minute). Implications for differential diagnosis and the establishment of phenotypes for developmental language disorders are discussed.

Keywords: Conversational profiles, ADHD, SLI, MLU, tense marking, mazes.

Introduction

One of the strengths of conversational based measures of language performance is the multidimensional nature of linguistic proficiency can be assessed directly. Spontaneous language samples provide important first hand information regarding children's performances in the areas of speaking rate, utterance formulation, lexical diversity, average utterance length and morphosyntactic complexity. Furthermore, variation in conversational profiles can reveal important differences across groups of children with language impairments (cf. Leadholm and Miller, 1992; Miller, 1996) that can assist differential diagnosis and direct service planning. In this study, conversational indices of language impairment were used to compare children with attention-deficit/hyperactivity disorder (ADHD) to children with specific language

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impairment (SLI) and typically developing children (TD). Although children with ADHD are often characterized as at risk for language delays and disorders based on their performance on standardized language tests and checklists (Barkley, 1997; Cohen, Davine and Meloche-Kelly, 1988; Cohen, Menna, Vallance, Barwick, Im and Horodezky, 1998; Cohen, Davine, Horodezky, Lipsett and Isaacson, 1993; Cohen, Vallance, Barwick, Im, Menna, Horodezky and Isaacson, 2000; Gualtieri, Koriath, Van Bourgodiën and Saleeby, 1983; Javorsky, 1996; Love and Thompson, 1988; Riccio and Hynd, 1993; Tannock and Schachar, 1996), very little information exists regarding the conversational productions of these children (Barkley, Cunningham and Karlsson, 1983; Ludlow, Rapoport, Bassich and Mikkelsen, 1980; Zentall, 1988). More importantly, no direct comparison of the conversational characteristics of children with ADHD and children with SLI is currently available, so the extent to which language samples analyses could assist the process of differential diagnosis of these two common developmental disorders is unknown.

Language symptoms associated with ADHD

Attention-deficit/hyperactivity disorder (ADHD) is defined by developmentally inappropriate levels of impulsivity, hyperactivity and inattention that cause functional impairments in multiple settings (American Psychiatric Association, 1994). ADHD is the most common psychiatric disorder diagnosed in childhood, affecting 3–5% of the school-age population (NIH Consensus Development Panel, 2000; Scahill and Schwab Stone, 2000; Szatmari, Offord and Boyle, 1989). Children with ADHD represent a highly heterogeneous group, but a significant proportion presents with additional language, learning and reading limitations that negatively impact their educational and occupational outcomes (cf. Barkley, 1997; NIH Consensus Development Panel, 2000). When compared to typically developing children, children with ADHD have been shown to be at increased risk for several markers of language impairment including: delayed onset of first words and word combinations, poor performance on standardized tests (vocabulary, syntax, reading fluency and short term memory), discourse limitations producing cohesive narratives and pragmatic difficulties associated with inappropriate conversational participation (Barkley, 1997; Cohen *et al.*, 1988; 1993; 1998; 2000; Love and Thompson, 1988; Purvis and Tannock, 1997; Tirosh and Cohen, 1997). Epidemiological studies using standardized language test batteries suggest that significant levels of language impairment can be expected to co-occur in 35–50% of children who present with ADHD symptoms and rates up to 90% have been observed in studies using clinically referred samples (see Tannock and Schachar, 1996 for a review).

Relationships between language impairments and ADHD

A very prominent explanation for the apparent overlaps between language and attention disorders in children is that both are caused by general neurodevelopment delays. Support for this perspective comes from studies that have found associations between measures of language, attention and cognitive abilities in early development. For example, Tallal, Dukette and Curtiss (1989) found significant correlations between levels of language impairment, attention problems and motor delays in their clinically ascertained sample of 86 preschool children with language

impairments. These investigators concluded that primary perceptual and motor delays were probably responsible for both the language and attention deficits observed. Beitchman, Hood, Rochon, Peterson, Mantini and Majumdar (1989) reached similar conclusions based on observations of high levels of overlap between moderate/severe levels of attention and language deficits (59%) in an epidemiological sample of 188 5-year-old children identified as speech/language impaired.

In a similar vein, Boucher (2000) suggested that developmental disorders with linguistic symptoms, such as autism, SLI and ADHD might represent a continuum of 'defective time parsing mechanisms'. Time parsing mechanisms represent various perceptual and cognitive processes involved in the efficient segmentation and analysis of linguistic and non-linguistic information. In this taxonomy, differences in the cognitive and linguistic symptoms traditionally associated with separate diagnostic categories reflect differences across children in the severity of their underlying biopsychological deficits (see also Tallal, Merzenich, Miller and Jenkins', 1998 characterization of SLI, ADHD, Central Auditory Processing Disorder and Pervasive Developmental Disability as temporal processing deficits and Barkley's (1997) characterization of ADHD as 'time blindness'). Thus, observations of 'overlap' between SLI and ADHD would represent an expected outcome that simply marks the fuzzy boundaries imposed upon a continuum of temporal processing limitations.

Another possibility for the overlap between language impairments and ADHD is that linguistic deficits may develop in children with ADHD as a secondary consequence of their deficits in impulsivity, hyperactivity, and inattention. For example, Love and Thompson (1988) evaluated the language skills of 85 children with ADHD referred for mental health services and found that most of the children (75%) received a dual diagnosis of speech/language disorder. Based on the high levels of observed language deficits in this clinical sample, these investigators suggested that deficits in information processing and social referencing associated with ADHD may have compromised the social interactions that supported these children's language learning. Tannock and Schachar (1996) suggested that executive dysfunctions associated with ADHD (i.e. limitations in self-directed actions and goal directed behaviour, organization of behaviour over time, the use of plans and deferred gratification) could account for both the core symptoms of the disorder as well as the development of commonly observed concomitant language/learning symptoms in these children. Furthermore, the presence of underlying executive dysfunctions might create a unique profile of language symptoms associated with ADHD, one that could be differentiated from the profiles associated with language, learning, and reading disabilities. To support their argument, Tannock and Schachar (1996) noted that evidence of language deficit associated with ADHD has been most consistent in the areas of expressive language, particularly pragmatics (e.g. utterance formulation, topic maintenance, interrupting conversation, excessive talk), and that problems in this dimension have appeared in affected children with intact receptive and expressive abilities in phonology, semantics, and syntax.

In sum, the risk for language impairments in children with ADHD is well documented but its ontogenesis is poorly understood. Variation across studies in the reported rates of co-occurrence has been considerable, prohibiting any conclusive integration. The available evidence is consistent with several different accounts including the possibility that children with ADHD and SLI exhibit similar

psycholinguistic profiles that are differentiated primarily by their levels of severity and an alternative possibility that ADHD is associated with a unique profile of psycholinguistic strengths and weaknesses.

Common limitations associated with testing protocols

A clear understanding of the relationship between ADHD and language disorders is important for the development of diagnostic protocols and for the establishment of behavioural phenotypes for both developmental language impairments and attention deficit disorders. Considerable empirical and conceptual obstacles, however, have kept this relationship opaque. For example, many study samples have been based on broadly defined clinical groups where language and attention deficits have been confounded with other clinical conditions (such as mental retardation, phonological disorder, and reading disability) and wide age ranges appear in the literature. In addition, the reported overlap between language impairments and attention deficits may have been in part the result of common testing artifacts. By design, psycholinguistic tests observe children's performance within the context of various non-linguistic task demands that require sustained attention, impulse control, working memory, and planning/organization. Thus, poor performance by children with ADHD may have reflected specific deficiencies in these areas and not necessarily reference general limitations in their control of the conceptual or structural components of language (i.e. semantics, morphology, syntax). A few studies have examined this issue and their results encourage caution when interpreting reports of deficient standardized language test performance. For example, Oram, Fine, Okamoto and Tannock (1999) compared the performance of 25 children with ADHD-only to 28 children identified as having ADHD and a language impairment (ADHD+LI), and 24 typically developing children on the Clinical Evaluation of Language Fundamentals-Revised (CELF-R). Even though children in the ADHD-only group were identified, a priori, as 'not language-impaired' on the basis of their overall receptive language or expressive language CELF-R quotients, these children consistently performed worse than the typically developing controls on some of the CELF-R subtests (Formulated Sentences, Word Structure and Sentence Assembly). The CELF-R Formulated Sentences subtest was particularly difficult for the ADHD-only group, whose mean performance fell more than one standard deviation below the normative sample's mean. Kim and Kaiser (2000) found similar results in their comparison of 11 children with ADHD and 11 typically developing children (ages 6–8) on the Test of Language Development-Primary, Second Edition (TOLD-P 2). In this case, the Sentence Imitation subtest proved to be disproportionately challenging for the children with ADHD.

The measurement of attention deficit and other areas of behavioural deviance may be similarly compromised by the presence of linguistic confounds within standardized psychological protocols. Redmond (2002) reviewed five commonly used psychiatric checklists and found that items which either measured linguistic proficiency directly (e.g. speech problems, doesn't speak clearly) or indirectly (e.g. has difficulty following directions, has difficulty learning) figured prominently on standardized parent and teacher behavioural rating scales. More importantly, these

language items frequently appeared on those sub-scales specifically designed to identify clinical levels of attention deficit/hyperactivity. Symptom overlap has also been noted within the DSM criteria used by psychiatrists and psychologists to diagnosis ADHD. For example, Camarata and Gibson (1999) suggested that many of the core DSM symptoms of ADHD (e.g. often does not seem to listen when spoken to directly; often has difficulty awaiting a turn; often interrupts or intrudes on others) could be recast within the framework of a primary pragmatic deficit. Given the recognized potential for symptom overlap and the apparent biases and confounds on both standardized tests of language and behavioural deficiency, it seems that an important step to unravelling the relationship between ADHD and language impairment is to find confirming evidence from additional measures of language impairment.

Conversational indices of language impairment

Conversational samples offer several advantages over standardized tests procedures and are regarded by many speech clinicians and clinical researchers as a critical element of the diagnosis and management of language disorders in children (Evans, 1996; Evans and Miller, 1999; Kemp and Klee, 1997; Miller, 1996; Miller, Frieberg, Rolland and Reeves, 1992). For example, conversational samples document children's ability to use a variety of language forms across a range of functional contexts and can be collected as often as needed without the risk of performance bias associated with standardized tests. Conversational indices also appear to have higher ecological validity than many standardized test batteries because they represent a better match to clinician-generated typologies of language production disorders (Evans and Miller, 1999; Miller, 1996; Miller *et al.*, 1992). Miller (1996) identified four language problem areas in particular that can be evaluated through conversational sample analysis: delayed language development, word-finding problems, utterance formulation deficits and rate of message-transference problems.

Scott and Windsor (2000) examined these linguistic dimensions within the language samples of 9–12-year-old children and found that some, but not all, of these areas successfully differentiated their study sample of 20 children with language learning disabilities (LLD) from the typically developing control children. Words-per-minute and number of grammatical errors produced differentiated the performances of the affected children from the non-affected children. Specifically, children in the LLD group spoke at slower rates and produced more grammatical errors. In contrast, utterance formulation measures (e.g. proportion of utterances containing a maze, average number of words per maze) and lexical diversity (e.g. number of different words produced) did not differentiate the two groups. There are contrasting views on the diagnostic value of mazes (which include false starts, fillers, revisions, and repetitions). Other investigators have reported that mazes may represent a problem area for some school age children with developmental and acquired language disorders (Dollaghan and Campbell, 1992; MacLachlan and Chapman, 1988; Miller, 1996).

Studies of younger children with SLI have demonstrated very high levels of sensitivity and specificity using conversational indices of linguistic proficiency. For example, since the 1970s, studies based on preschool, kindergarten, and early elementary grade school samples of children with SLI have used lower than normal

MLU values as an eligibility criterion (cf. Leonard, 1998), providing evidence of acceptability for the use of this measure as a marker of developmental language impairments. Number of different words produced within 100 utterances has also been shown to discriminate preschool children with SLI from their typically developing peers (Klee, 1992; Watkins, Kelly, Harbers and Hollis, 1995), although the results of Scott and Windsor (2000) suggest limited utility when used with older children with language learning disabilities. Rice, Wexler and Cleave (1995) used a composite measure of tense marking that represented the arithmetic mean of children's correct productions of the regular past tense *-ed*, third person singular present tense *-s*, copula and auxiliary *BE* forms and found almost no overlap in performance in their samples of 5-year-old children with and without SLI (see also Bedore and Leonard, 1998; Rice, 2000). Longitudinal investigations suggest further that composite tense may be a highly sensitive measure of language impairment up to age 8 years (Rice, 2003; Rice, Wexler and Hershberger, 1998).

Are these areas of linguistic proficiency similarly difficult for children with ADHD? Within the handful of studies that have measured the conversational productions of children with ADHD, these particular indices have unfortunately been examined sporadically. Barkley *et al.* (1983) is representative of this line of research. In this study, the mother-child conversations of 18 9-year-old children with ADHD were compared to typically developing age-matched control children. On the basis of total number of utterances and average number of syllables produced by both groups of children, Barkley *et al.* (1983) concluded that the conversational productions of children with ADHD were appropriate for their age expectations. Zentall (1988) examined the language samples of 22 9-year-old children with ADHD and a group of age matched controls and reached similar conclusions based on the total number of words, sentences, grammatical errors, repetitions and revisions produced during different story telling tasks. Ludlow *et al.* (1980) also used a story telling task to elicit language samples from 12 boys (age range: 6–12 years) with ADHD and 12 age-matched controls. Twenty-one different measures of language performance (including MLU, words per minute and percentage of grammatical speech) yielded very few differences between the two groups. Children with ADHD were observed to produce significantly shorter stories and more off task speech. The authors did note, however, that many more of the measures of language performance were related to age for the ADHD participants whereas this was not the case for the typically developing controls, suggesting that 'the younger hyperactive subjects were delayed in their use of complex linguistic structures in their spontaneous speech' (Ludlow *et al.*, 1980, p. 194).

Questions directing current study

The conversational productions of young children with ADHD warrant further investigation. Two specific questions directed the current study.

1. Do children with ADHD demonstrate deficits in empirically validated conversational indices of language impairment?
2. Are the differences between the conversational profiles associated with ADHD and SLI more a matter of degree or do they represent distinct conversational phenotypes associated with the two developmental disorders?

Method

Participants

Participant characteristics are displayed in table 1. All of the participants were monolingual speakers of English and demonstrated normal levels of hearing acuity, non-verbal achievement, and speech production skills. Three groups of children (age range 5;0 to 8;2 yrs; mos.) were matched within 6 months for chronological age: ten children diagnosed with SLI, ten children diagnosed with ADHD, and 13 control children with typical development (TD). Although the mean age for the ADHD group was slightly higher than the other two groups, non-significant group comparisons confirmed the equivalence of groups on the matching variable [age in months: $F(2,30)=1.981$, $p=0.156$]. Group equivalence was also observed in reported levels of maternal education and children's non-verbal IQ scores [mothers' education: $F(2,30)=0.244$, $p=0.785$; non-verbal IQ: $F(2,30)=2.842$, $p=0.075$]. As expected, significant group differences were observed on the independent variables of language achievement and behavioural performance [language: $F(2,30)=34.517$, $p<0.0001$; behavioural $F(2,30)=13.522$, $p<0.0001$].

Each participant completed the following assessment protocol: (a) a parental questionnaire, documenting the participant's developmental, academic, and family histories and current status of service receipt; (b) a hearing screening at 25 dB at 1000, 2000 and 4000 Hz, establishing normal hearing acuity; (c) the Columbia Mental Maturity Scale (CMMS; Burgemesiter, Blum and Lorge, 1972), establishing normal nonverbal achievement (i.e. an age deviation score 85 or higher); (d) a phonological screening, verifying consistent use of word final -s, -z, -t and -d (9/10 items correct); (e) the Test of Language Development Primary-Third Edition (TOLDP-3; Newcomer and Hammill, 1997), documenting the participant's general language levels; and (f) the Child Behavior Checklist (CBCL; Achenbach, 1991), documenting the participant's behavioural status.

Potential SLI participants were recruited from the University of Utah Speech, Language, and Hearing Clinic and from the caseloads of certified speech language pathologists in neighbouring school districts. To be included in the SLI group (seven boys, three girls; ten Caucasian), children needed to demonstrate the following characteristics: (a) a diagnosis of language impairment by a certified

Table 1. *Participant characteristics: group means and (standard deviations)*

	Age ^a	Maternal Education ^b	Nonverbal ^c	Behavioural ^d	Language ^e
ADHD	83 (10)	2.9 (1.4)	99 (8)	71 (8)	95 (13)
SLI	79 (11)	3.0 (.67)	104 (11)	62 (11)	74 (11)
TD	79 (9)	3.2 (1.2)	107 (6)	53 (6)	111 (9)

^aAge: in months.

^bMaternal Education: scale of 1=some high school and 5=some graduate school.

^cNonverbal: Columbia Mental Maturity Scale, age deviation score (M=100, SD=15).

^dBehavioural: Child Behavior Checklist, attention problems scale *T* score (M=50, clinical cut-off=67).

^eLanguage: Test of Language Development Primary-Third Edition, spoken language quotient (M=100, SD=15).

speech language pathologist and receipt of services at the time of the study; (b) a performance below 1.0SD on at least two of the six core sub-tests from the Test of Language Development Primary-Third Edition (TOLD-P 3); and (c) no concomitant diagnosis of autism, PDD, or ADHD. Seven of the ten participants in the SLI group had participated in an earlier study examining children's development of past participles (see Redmond, 2003 for further details).

Although the SLI group mean on the CBCL Attention Problems sub-scale was within normal limits, five of the ten children were rated by their parents as having attention problems at or above the clinical cut-off value. This observation of elevated levels of concomitant attention problems within study samples of children with SLI relative to normative expectations was consistent with some previous reports (e.g. Beitchman, Nair, Clegg, Ferguson and Patel, 1986; Beitchman, Brownlie and Wilson, 1996; Cantwell and Baker, 1985; Goodyer, 2000) but discrepant with others (e.g. Redmond and Rice, 1998; 2002).

Potential ADHD participants were recruited through referrals from paediatricians, psychiatrists, and clinical psychologists practicing in Salt Lake City and surrounding communities. To be included in the ADHD group (nine boys, one girl; nine Caucasian, one Hispanic), children needed to demonstrate the following characteristics: (a) a diagnosis of ADHD by a licensed psychiatrist or clinical psychologist and receipt of services at the time of the study; (b) a behavioural rating greater than 1.0SD above the mean on the Attention Problems sub-scale of the Child Behavior Checklist (Achenbach, 1991); (c) no concomitant diagnosis of autism, PDD, language impairment, phonological disorder or learning/reading disability. All of the children with ADHD were receiving stimulant medication for the management of their symptoms at the time of the study and all testing data and conversational samples were collected from these children under medication (within four hours of their last dose). The decision to test children on medication was motivated by the guidelines for best practice provided by the American Speech Language and Hearing Association (ASHA, 1997) and was considered to be consistent with the principles of reasonable accommodation.

Although the ADHD group mean on the overall TOLD-P3 spoken language quotient was well within normal limits, a significant proportion of children in this group (4/10) experienced difficulty with some of the sub-tests (specifically, performance below 1.0SD on the Oral Vocabulary/Sentence Imitation sub-tests). Consequently, three of these four children achieved overall TOLD-P3 spoken language quotients below 1.0SD. This observation of selective difficulties across language subtests in children with ADHD was consistent with earlier reports (Oram *et al.*, 1999; Kim and Kaiser, 2000). In particular, this sample replicated the finding that sentence imitation deficits are likely to appear in children with ADHD.

Potential TD participants were recruited through after-school and daycare programmes in the same communities as the children in the other two groups. Children included in the TD group (nine boys, four girls; 12 Caucasian, one Hispanic) presented with unremarkable developmental and educational histories (as indicated by parental report), were not receiving any special or remedial services at the time of the study, and scored within normal limits ($\geq 1.0SD$) on each of the standardized measures of verbal, non-verbal, and behavioural performance used in this study.

Sampling procedures

Thirty-minute conversational samples were collected during free-play with an examiner using a set of age appropriate toys (taken from the Playmobile™ rescue helicopter, hospital and camping sets). The same toy sets were used for all children. Sony TC-D5 PRO II tape recorders with tiepin ECM-T140 external microphones were used. Examiners (the author and graduate student assistants in Communication Sciences and Disorders) were trained to limit their use of yes/no and wh-questions since these have been shown to differentially affect the conversational productions of children with SLI relative to typically developing children (Johnston, Miller, Curtiss and Tallal, 1993). Following sample collection suggestions provided by Hadley (1998), examiners were also instructed to contribute personal anecdotes involving hospital/camping experiences during the conversation. These personal narratives were followed up with requests for similar information from the children (e.g. 'Tell me what happened when you went camping').

Within 2 weeks of collecting each sample, examiners transcribed and entered samples into the Systematic Analysis of Language Transcripts (SALT version 6.1, Miller and Chapman, 2000) using the coding conventions established for the Kansas Language Transcript Database (Howe, 1996). A second examiner checked each transcript for spelling/typographical errors, as well as for transcription, segmentation, and coding errors. Disagreements between examiners were resolved through consensus whenever possible. If disagreements between examiners were not resolved after three passes, disputed portions were coded as 'unintelligible'.

The following conversational measures were used to explore group differences: (1) words per minute (Leadholm and Miller, 1992); (2) mazed words as per cent of total words (Leadholm and Miller, 1992); (3) average number of words per maze (Leadholm and Miller, 1992); (4) number of different words produced in 100 utterances (Leadholm and Miller, 1992); (5) mean length of utterance in morphemes (MLU) based on the total number of complete and intelligible utterances (Leadholm and Miller, 1992) and (6) composite tense, based on the arithmetic mean of each child's correct production of copula and auxiliary BE, regular past tense *-ed*, and third person singular present tense *-s* within obligatory contexts (cf. Rice *et al.*, 1995).

Inter-transcriber agreement

Two conversational samples were randomly selected from each group (six total) to estimate inter-transcriber agreement. The selected samples were transcribed independently by another transcriber and agreement was calculated using the total number of agreements divided by the total number of agreements + disagreements. Inter-transcriber agreement was determined separately for the total number of morphemes, for the total number of utterance boundaries and segmentations, and for the total number of mazes yielding overall levels of 98%, 97% and 93% respectively.

Results

Table 2 displays the group means and standard deviations associated with each of the dependent measures. Group differences were explored through parametric

Table 2. *Conversational indices of language impairment: group means and (standard deviations)*

Conversational Measure	Group		
	ADHD	SLI	TD
Speaking rate			
1. Words per minute	55.29 (18)	35.50 (25)	45.58 (14)
Utterance formulation			
2. Per cent words mazed	8.5 (2.64)	6.0 (2.64)	5.8 (1.54)
3. Average number of words/maze	1.67 (0.31)	1.43 (0.32)	1.37 (0.24)
Lexical diversity			
4. Number of different words, 100 utterances	164.70 (34)	129.60 (25)	159.46 (22)
Utterance Length			
5. MLU	5.25 (0.87)	4.07 (0.82)	4.81 (0.61)
Morphosyntactic Development			
6. Composite tense	0.97 (0.04)	0.79 (0.18)	0.98 (0.02)

analyses. Omnibus one-way between subjects ANOVAs were used to verify the presence of significant group differences. In those instances where homogeneity of variance could be assumed, follow-up Dunn-Sidak analyses identified pair-wise comparisons that reached the 0.05 level of significance. In those instances where Levene's Test for Homogeneity of Variances was significant, follow-up Dunnett's C analyses identified pair-wise comparisons that reached the 0.05 level of significance. Box-plots were used to examine further the degree of overlap between groups, which are presented in figures 1–6.

Faster-than-average speaking rates have been attributed to some children with ADHD, although studies suggest this may not be the case for all children. In contrast, some investigations suggest that children with SLI and other language learning disabilities may speak at relatively slower rates. Group means and standard deviations for speaking rate (words per minute) during the conversational samples were as follows: ADHD $M=55.29$, $SD=18$; SLI $M=35.50$, $SD=25$; TD $M=45.58$, $SD=14$. Group differences were not statistically significant ($p=0.095$). Box-plots for words per minute are presented in figure 1 and show that two children in the SLI group and one child in the TD group had higher than expected speaking rates relative to the other children in these groups. These results suggest that although children with ADHD had, on average, faster speaking rates than children in either the SLI or TD groups and that children with SLI tended to speak at relatively slower rates, individual variation in this case rendered group differences non-significant.

Previous research suggests that some children with language impairments have deficits in the area of utterance formulation. Group means and standard deviations for the two measures of utterance formulation used in this study were as follows: per cent words mazed, ADHD $M=8.5$, $SD=2.64$; SLI $M=6.1$, $SD=2.64$; TD $M=5.8$, $SD=1.54$, and average number of words per maze, ADHD $M=1.67$, $SD=0.31$; SLI $M=1.43$, $SD=0.32$; TD $M=1.37$, $SD=0.24$. Group differences were significant in both cases [per cent words mazed: $F(2,30)=4.612$, $p=0.018$, ($\eta^2=0.235$); average number of words per maze: $F(2,30)=3.449$, $p=0.045$, ($\eta^2=0.187$)]. Homogeneity of variances was assumed. The following pair-wise comparisons for

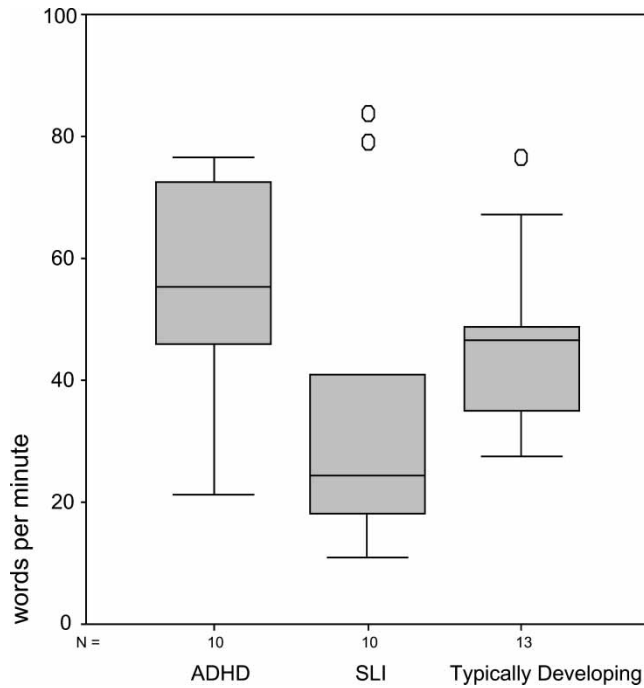


Figure 1. *Box-plots for words per minute displaying group medians, first and third quartiles, 10th and 90th percentiles, outliers (o) and extreme scores (*).*

both utterance formulation measures reached the 0.05 level of significance: ADHD > SLI = TD. Box-plots for measures of utterance formulation are presented in figures 2 and 3. Figure 2 shows little overlap between the ADHD group and the other two groups in the per cent words mazed but figure 3 shows some overlap across groups in the average number of words mazed. On both measures, outliers were observed within the TD group. These results suggest utterance formulation difficulties were more characteristic of the conversational productions of children with ADHD than the productions of children with SLI, who were in contrast very similar to the typically developing controls in this regard.

Lexical diversity, as indexed by number of different words produced, represents another marker of language impairment, especially in younger children. Group means and standard deviations for number of different words used in 100 utterances were as follows: ADHD $M=164.7$, $SD=33$; SLI $M=129.60$, $SD=25$; TD $M=159.46$, $SD=22$. Homogeneity of variances was assumed. Group differences were significant, $F(2,30)=5.136$, $p=0.012$ ($\eta^2 0.255$), and the following pair-wise comparisons reached the 0.05 level of significance: SLI < ADHD = TD. Box-plots for number of different words are presented in figure 4 and show little overlap between the SLI group and the ADHD and TD groups. These results suggest that lexical diversity as indexed by number of different words produced was not a problem area for children with ADHD but was associated with the diagnosis of SLI.

Reduced average utterance length is a frequently reported problem area for children with language impairments. Group means and standard deviations for

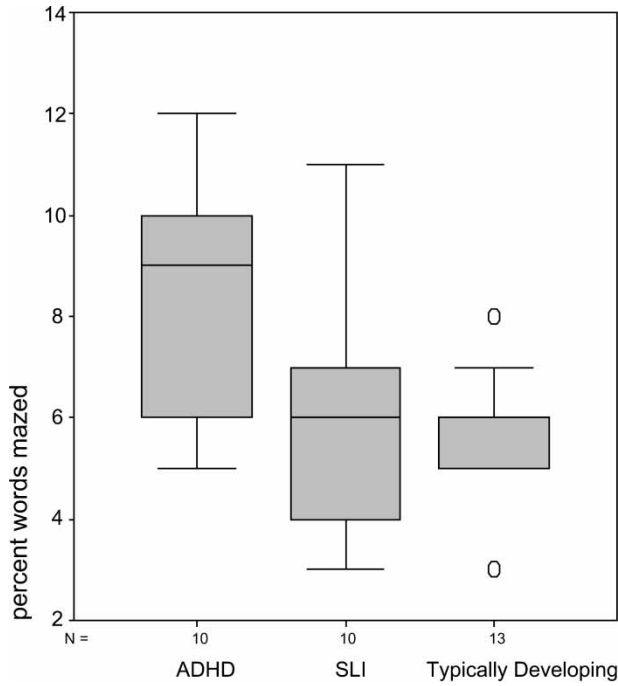


Figure 2. Box plots for percent words mazed displaying group medians, first and third quartiles, 10th and 90th percentiles, outliers (0) and extreme scores (*).

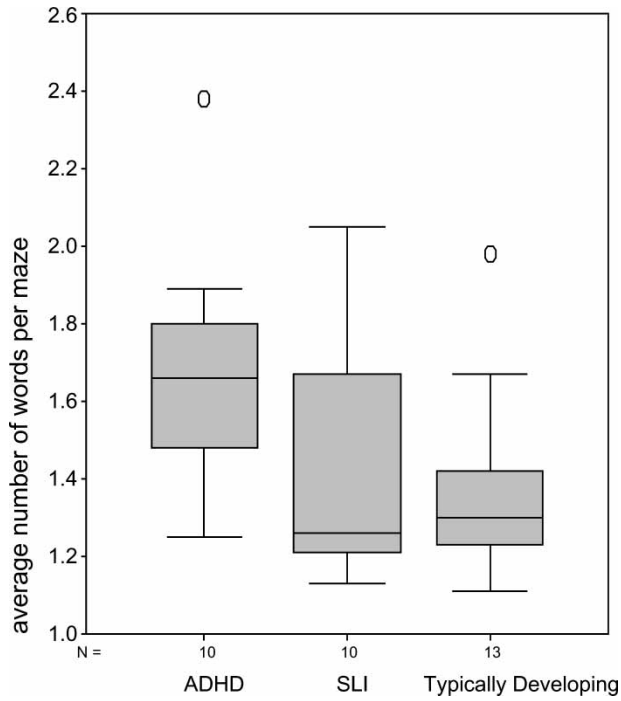


Figure 3. Box-plots for average number of words per maze displaying group medians, first and third quartiles, 10th and 90th percentiles, outliers (0) and extreme scores (*).

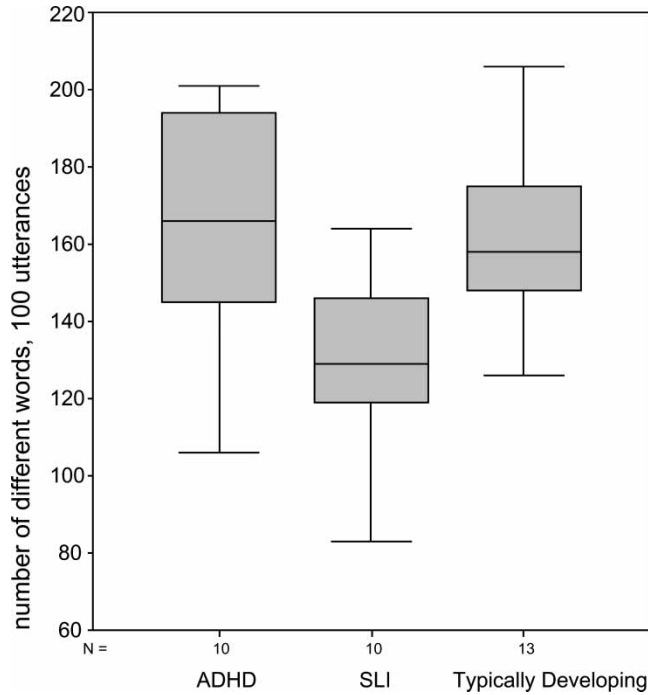


Figure 4. Box-plots for number of different words displaying group medians, first and third quartiles, 10th and 90th percentiles, outliers (0) and extreme scores (*).

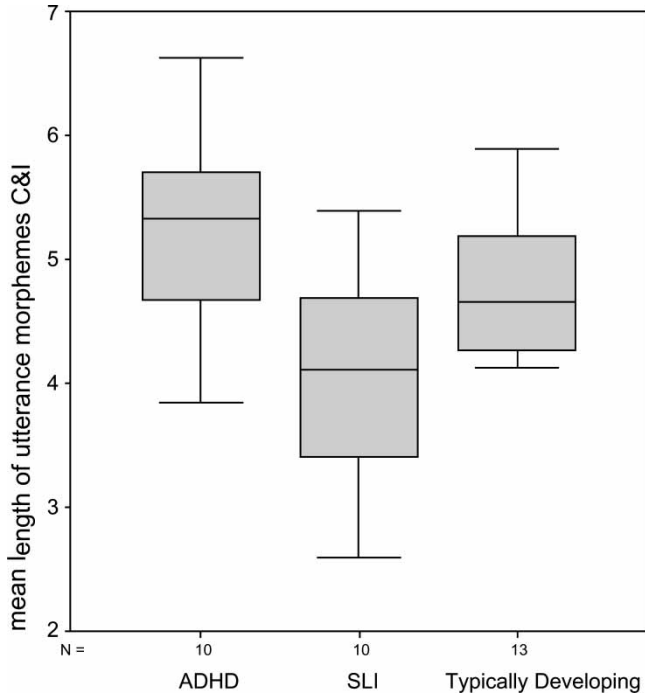


Figure 5. Box-plots for mean length of utterance displaying group medians, first and third quartiles, 10th and 90th percentiles, outliers (0), and extreme scores (*).

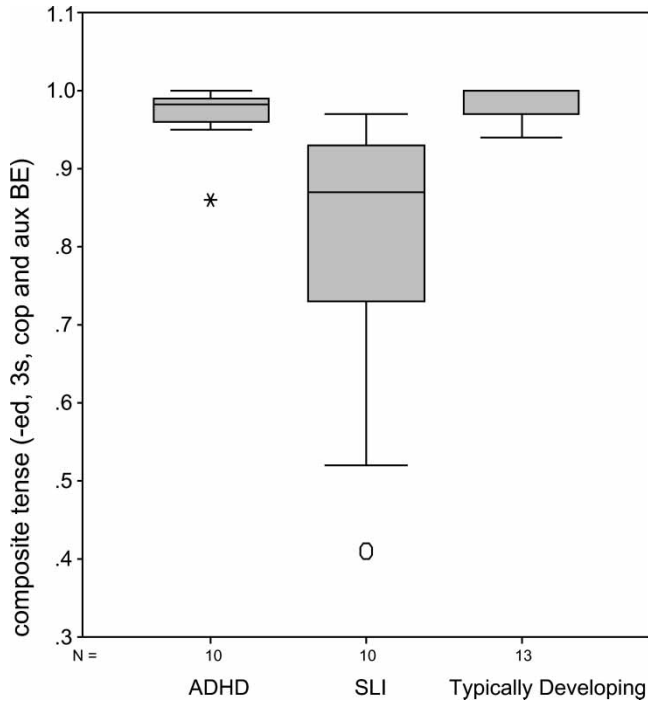


Figure 6. *Box-plots for composite tense displaying group medians, first and third quartiles, 10th and 90th percentiles, outliers (o) and extreme scores (*).*

MLU in complete and intelligible utterances produced were as follows: ADHD $M=5.25$, $SD=0.87$; SLI $M=4.07$, $SD=0.82$; TD $M=4.81$, $SD=0.61$. Group differences were significant, $F(2,30)=6.351$, $p=0.005$ ($\eta^2=0.297$) and homogeneity of variances was assumed. The following pair-wise comparisons reached the 0.05 level of significance: $SLI < ADHD = TD$. Box-plots for MLU are presented in figure 5 and show considerable overlap between the TD and ADHD groups but little overlap between the SLI group and the other two groups. These results suggest that MLU was not a problem area for children with ADHD but was associated with the diagnosis of SLI.

Composite tense marking has been shown to be highly sensitive in identifying SLI in children across a wide age range. Group means and standard deviations for composite tense were as follows: ADHD $M=0.97$, $SD=0.04$; SLI $M=0.79$, $SD=0.19$; TD $M=0.98$, $SD=0.02$. Group differences were highly significant, $F(2,30)=10.406$, $p < 0.001$ ($\eta^2=0.410$). Homogeneity of variances was not assumed (Levene statistic $p < 0.05$). The following Dunnett C pair-wise comparisons reached the 0.05 level of significance: $SLI < ADHD = TD$. Box-plots for composite tense are presented in figure 6 and show almost no overlap between the SLI group and the other two groups. One outlier in the ADHD group had a composite tense score that was the same value as the SLI group median. These results suggest that 5–8-year-old typically developing children as well as most children with ADHD can be expected to have mastered tense marking with very little within group variation. In contrast, children with SLI of similar ages will probably continue to demonstrate lower levels of proficiency in this area of their grammar.

Discussion

Standardized test performance represents the primary basis for the characterization that children with ADHD are at elevated levels of risk for language impairments. Studies using psycholinguistic tests and behavioural rating scales have reported considerable overlap between children with ADHD and children with SLI (Beitchman *et al.*, 1986, 1996; Cantwell and Baker, 1985, 1991; Cohen *et al.*, 1998, 2000; Javorsky, 1996; Love and Thompson, 1988; Riccio and Hynd, 1993; Tallal *et al.*, 1989, 1998; Tannock and Schachar, 1996). Using standardized tests as the 'gold standard of affectedness', around half of the children from each of the clinical groups in this study presented with comorbid symptomatology. The purpose of this study, however, was to compare the conversational profiles of young children with ADHD, SLI and typical development in order to confirm this characterization of overlap between these clinical populations. The language sample analysis provided a very different picture than the standardized test battery and suggested more differences than similarities between children with ADHD and children with SLI. For example, children with ADHD were found to produce significantly more mazes and longer mazes than children with SLI or typically developing children. In contrast, children with SLI were found to have specific limitations in the areas of number of different words, MLU and composite tense. The composite tense measure in particular documented very little overlap between the SLI group and the ADHD and typically developing groups. This result supports the characterization that grammatical tense may represent a unique clinical marker of SLI that indexes 'unexpected variation' (Rice, 2003).

The results of this study are also consistent with the executive dysfunction hypothesis of language limitations associated with ADHD offered by Tannock and Schachar (1996). These authors suggested that the presence of ADHD leads to a unique profile of psycholinguistic strengths and weaknesses that is distinguishable from SLI and other language learning disabilities. In this regard, utterance formulation deficits during conversational samples may represent a clinical marker of executive dysfunction. There is some support for this hypothesis from studies of children and adults with traumatic brain injuries involving frontal and pre-frontal areas (e.g. Dollaghan and Campbell, 1992; Garrett, 1992), which also report high rates of mazing behaviours in these populations. Future studies will need to examine more closely the conversational similarities and differences between children with ADHD and these other populations as well as explore the effect that different sampling contexts have on children's mazing behaviour (conversation, narrative, story retell, etc.).

The results of this study clearly warrant further corroboration. Additional research is needed to establish levels of sensitivity and specificity of these developmental profiles as a function of disability. However, if the pattern of observed differences between the clinical groups holds in further investigations, conversational sample analysis will be an important component of the differential diagnosis of SLI from ADHD and in the identification of comorbidity. Improvements in differential diagnosis will place speech language pathologists and mental health care professionals in a better position to insure that children referred for either speech or psychiatric services receive the most appropriate combination of interventions.

The results of this study, as well as Oram *et al.* (1999) and Kim and Kaiser (2000), also suggest that information gathered from standardized testing needs to be

interpreted with caution because children's performances on psycholinguistic tests are probably influenced by various non-linguistic task demands that penalize children with ADHD. This is a serious consideration, not only for clinical practice but also for current efforts to locate the genetic contributions to SLI (e.g. SLI Consortium, 2002) because those behavioural phenotypes that rely exclusively on standardized test measures will inevitably reveal genetic overlap between SLI and ADHD. In contrast, phenotypes that include conversational dimensions may have a better chance of identifying the unique genetic factors associated with SLI.

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